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Black-capped Vireo and Golden-cheeked Warbler Populations Potentially Impacted by USACE Reservoir Operations

by Michael P. Guilfoyle

Black-capped vireo

Golden-cheeked warbler

PURPOSE: This document is part of a series of technical notes concerning species that may be potentially impacted by U.S. Army Corps of Engineers (Corps) reservoir operations and associated activities. These technical notes are prepared for the Corps Ecosystem Management and Restoration Research Project (EMRRP) work unit entitled "Reservoir Operations – Impacts on Habitats of Target Species," (see Dickerson, Martin, and Allen (1999); Kasul, Martin, and Allen (2000)). This technical note provides information on the status and management of two protected bird species that are often located along steep slopes and canyons in the Edward Plateau region of south-central Texas. Habitat requirements for each species are discussed, and information is provided concerning the factors contributing to population declines and recovery efforts currently being implemented. Details on the status of each species, its distribution, habitat, behavior, reproduction, food habits, impacts, and management are provided in separate sections below.

BACKGROUND: The black-capped vireo (*Vireo articapillus*) and the golden-cheeked warbler (*Dendroica chrysoparia*) are two sensitive non-riparian species found in south-central Texas that may be potentially impacted by Corps reservoir operations. Although these species are considered non-riparian, both species are often located along steep gullies and canyons and are therefore linked to river and stream systems. Both the black-capped vireo and the golden-cheeked warbler are federally listed as endangered (U.S. Fish and Wildlife Service (USFWS) 1986, 1987, 1990a, 1990b, 1990c) under the Endangered Species Act (ESA) (1973).

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Both the black-capped vireo and the golden-cheeked warbler potentially breed in the vicinity of six reservoirs in central Texas (Mitchell, Martin and Dickerson 2000). Four of these reservoirs are under the authority of the Little River project within the Fort Worth District, while the other reservoirs are managed by the Mid-Brazos and Trinity projects (Figure 1). Presence of the black-capped vireo in the Little River project is based on available habitat, but no breeding individuals have been detected.[1] Populations of the golden-cheeked warbler have been located within the vicinity of Whitney Lake (Mid-Brazos Project) and Joe Pool Lake (Trinity Project). The presence of the black-capped vireo has only been confirmed in habitats around Whitney Lake.[2] Both species are also found on numerous state and federal lands and military installations in the region. The black-capped vireo is found on the Wichita Mountain National Wildlife Refuge, OK; Balcones Canyonlands National Wildlife Refuge, TX; and Big Bend National Park, TX (Travis Audubon Society 2001a). The largest known population of this species is found on the Kerr Wildlife Management Area, which is managed by the Texas Parks and Wildlife Department (Travis Audubon Society 2001b; Baccus, Nelka and Harmel 1997). A large population of golden-cheeked warblers also breeds on the Balcones Canyonlands Wildlife Refuge in central Texas (Travis Audubon Society 2001c). Relatively large populations of both species occur at Fort Hood, TX, plus other smaller populations at the Camp Bullis Training Site of Fort Sam Houston, TX (U.S. Army, Fort Hood, Directorate of Public Works (DPW) 2001). The black-capped vireo is also present on Fort Sill, OK, and Camp Berkeley, TX (Schreiber and Reed 1999).

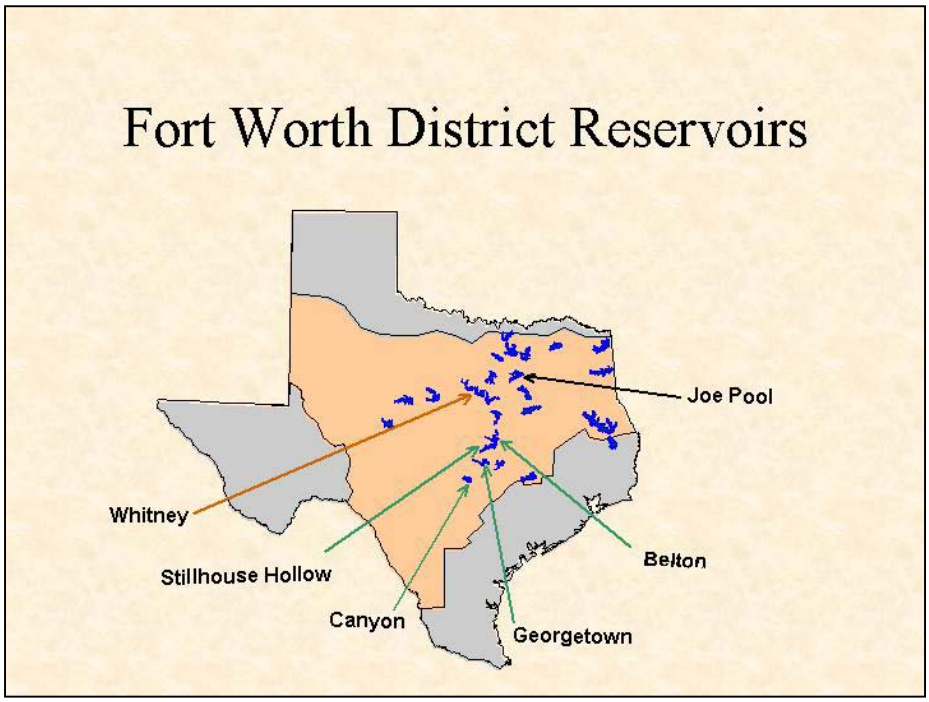

Figure 1. Reservoirs under Corps management in south-central Texas that may support black-capped vireos and golden-cheeked warblers. Colored arrows indicate jurisdiction of Corps projects that manage specific reservoirs: projects include Mid-Brazos (brown), Little River (green), and Trinity (black)

[1] Personal communication, 10 April 2001, Carey Webber, Environmental Specialist, Little River Project, Texas.
[2] Personal communication, 10 April 2001, Anjna O'Connor, Environmental Specialist, Mid-Brazos Project, Texas.

HABITAT REQUIREMENTS: While both species have similar ranges within central Texas, they occupy distinct habitats. The black-capped vireo is an early-successional species that utilizes areas of deciduous scrub dominated by oaks (*Quercus* spp.) interspersed with open areas and dense thickets. The golden-cheeked warbler is dependent on mature forest stands of Ashe juniper (*Juniperus ashei*) mixed with various oaks and other deciduous species. The golden-cheeked warbler uses the stringy loose bark of mature juniper trees as a principal ingredient in the construction of its nest. Although both species are often located along gullies and rocky slopes, the black-capped vireo is more likely to use plateaus and areas of relief (Grzybowski 1995), while the golden-cheeked warbler appears more closely associated with canyons and steep ravines (Ladd and Gass 1999). The black-capped vireo tends to avoid early-successional habitats dominated by Ashe juniper, while the golden-cheeked warbler tends to select forest tracts with a high proportion of mature juniper trees.

IMPACTS AND RECOVERY: Both the black-capped vireo and the golden-cheeked warbler have experienced population declines as a result of large losses and degradations of available breeding habitat. Much of the available habitat within the range of these two species has been converted to rangeland for cattle, agricultural fields, and urban sprawl. Overgrazing by cattle removes the dense vegetative thickets in early-successional habitats, reducing the suitability of the habitat for black-capped vireos. Grazing in the understory of mature juniper stands also degrades the habitat for golden-cheeked warblers. Historically, most early-successional habitats were created by natural fires, yet with an increasing human population and increasing urbanization, fire suppression has gradually removed breeding habitat for black-capped vireos. Fire suppression and habitat conversion are the principal reasons for the extirpation of the black-capped vireo from Kansas and most of Oklahoma (Grzybowski 1995). Flooding caused by the creation of reservoirs in central Texas may also be responsible for significant habitat loss for both species. During the spring of 1992, high water levels in several lakes managed by the Corps in the Fort Worth District flooded adjacent breeding populations of golden-cheeked warblers (Ladd and Gass 1999).

In addition to habitat loss, the expansion of cattle in the region paved the way for the invasion of the brown-headed cowbird (*Molothrus ater*). The cowbird is a brood parasite that lays its eggs in the nests of unsuspecting hosts. Both the black-capped vireo and the golden-cheeked warbler are vulnerable to cowbird parasitism and have experienced severe declines in reproductive success when parasitized. Moreover, fragmentation of habitat creates small isolated habitat patches that not only exacerbate the effects of brood parasitism, but also increase the rates of nest predation from reptilian, mammalian, and avian predators. The vulnerability of small isolated populations increases the likelihood of local extirpations and poses a serious threat to the long-term existence of both species.

Management strategies for black-capped vireo populations focus on control of brown-headed cowbirds and the identification, protection, and creation of suitable nesting habitat (USFWS 1991). Numerous methods have been used to create early successional habitat, but prescribed burning activities are usually the most effective (Campbell 1995). Black-capped vireos rapidly recolonize areas restored to an early-successional state. Golden-cheeked warblers also benefit from cowbird control, but management generally focuses on the identification and protection of mature juniper stands (USFWS 1992, Campbell 1995). Golden-cheeked warblers will also utilize second growth forests if suitable conditions exist; therefore, restoration of mature juniper forests is a priority. Minimum forest size for a viable population of golden-cheeked warblers is estimated at

approximately 7,500 acres (3,000 ha) (Ladd and Gass 1999), and the approved recovery plan proposes one sustaining population for each of eight identified subregions in central Texas, with each subregion containing between 1,000 and 3,000 breeding pairs (USFWS 1992, Ladd and Gass 1999).

Two of the largest, and most intensively managed, populations of black-capped vireos and golden-cheeked warblers occurs on Fort Hood, TX. This military installation supports an estimated 500 breeding pairs of black-capped vireos and 2,000 to 2,500 pairs of golden-cheeked warblers (Weinburg, Hyaden, and Cornelius 1998; Ladd and Gass 1999). Long-term monitoring of these species was initiated at Fort Hood during the mid-1980's and an intensive cowbird control program was implemented in 1988 (Ladd and Gass 1999). The golden-cheeked warbler was identified as a rare species and protected on the installation as early as 1970, nearly 20 years before the species was federally listed as endangered (U.S. Army, Fort Hood, DPW 2001). Cowbird control on the installation reduced the percentage of parasitized black-capped vireo nests from 90 percent to 20 percent, thereby greatly increasing nesting success for this species on the installation (Wienburg, Hayden, and Cornelius 1998). Similarly, cowbird control on Fort Hood between 1991 and 1997 reduced the percentage of parasitized golden-cheeked warbler nests from about 70 percent to less than 10 percent (Ladd and Gass 1999). Between 1991 and 1997, abundance of black-capped vireos increased nearly 40 percent on Fort Hood (Weinburg, Hayden, and Cornelius 1998), while golden-cheeked warblers remained stable between 1991 and 1996 (Jette, Hayden, and Cornelius 1998). In February 1996, a fire ignited by ordnance explosions on Fort Hood destroyed nearly 10,000 acres (4,000 ha) of golden-cheeked warbler habitat (U.S. Army, Fort Hood, DPW 2001), so populations of this warbler have likely declined significantly. A small population of golden-cheeked warblers on Camp Bullis decreased between 1991 and 1997, but increased significantly during 1999 and 2000; it currently holds at approximately 230 individuals (Fischer and Guilfoyle 2001).

In Texas, both the black-capped vireo and the golden-cheeked warbler breed on the Balcones Canyonlands National Wildlife Refuge and the Kerr Wildlife Management Area. The Balcones Canyonlands National Wildlife Refuge, approximately 30 miles northwest of Austin, TX, was established in 1992 specifically to protect populations of these two species (Cathey 1997). The refuge encompasses nearly 47,000 acres (18,600 ha) and supports one of the largest populations of golden-cheeked warblers in central Texas (Ladd and Gass 1999). Currently, there are plans to incorporate and protect an additional 30,750 acres (12,300 ha) using private landowners as part of the Balcones Canyonlands Conservation Plan (BCCP), but development and implementation of the plan are complex and have drawn considerable criticism (Ladd and Gass 1999). Numerous ranchers and other private landowners involved in the BCCP are voluntarily engaged in cowbird control and successfully reducing parasitism for the black-capped vireo. Management on the refuge includes identifying and protecting breeding populations of both species.

BLACK-CAPPED VIREO (*Vireo atricapillus*)

Distribution: The black-capped vireo was formerly a locally common bird distributed as far north as Kansas, but is now limited largely to western and central Texas and north-central Mexico, with a few scattered remnant populations in the Wichita Mountains of Oklahoma (DeGraaf and Rappole 1995, Grzybowski 1995) (Figure 2). The extent of its breeding range in central Mexico is still questionable (Benson and Benson 1990, Scott and Garton 1991, Grzybowski 1995). Within

Texas, the species range is concentrated along the geological fault line known as the Balcones Escarpment, with highest abundances observed within the Edwards Plateau (Grzybowski 1995). During the winter, this vireo is found along the Pacific slope in western Mexico (DeGraaf and Rappole 1995, Grzybowski 1995); however, the extent of the wintering range is poorly known.

Figure 2. Breeding and wintering range of the black-capped vireo in North America and Mexico (adapted from Grzybowski (1995) and the National Geographic Society (1999))

Status: The black-capped vireo was proposed for listing on October 6, 1986, as endangered under the ESA (US Fish and Wildlife Service (USFWS) 1986) and officially listed on November 5, 1987, (USFWS 1987, 1991), yet critical habitat has yet to be designated (Grzybowski 1995). Once considered common, this species probably ceased to breed in Kansas during the 1930s, though occasional observations continued into the 1950s (Grzybowski 1995). Only about 170 birds continue to breed in three counties in Oklahoma, while populations in Central Texas, particularly within the Edwards Plateau region, are estimated to number between 250 and 500 birds. The largest populations in Texas are found in Kerr County within the Kerr Wildlife Management Area, and in several parks within the city limits of Austin (Tveten 1993). A large population breeds on Fort Hood, and a much smaller population exists on the Camp Bullis Training Site of Fort Sam Houston, TX (Tazik, Cornelius, and Abrahamson 1993). A small population also exists on Fort Sill, OK. A few breeding individuals have been observed at Coahuila, Mexico, but population numbers are small (Scott and Garton 1991). Although incidental observations of this species have occurred in Nebraska, New Mexico, and Louisiana, breeding populations are currently limited to Texas and Oklahoma.

Habitat: The primary breeding habitat for the black-capped vireo is characterized by early-successional, deciduous scrub areas interspersed with vegetative thickets and open areas. Areas subjected to recent fires (i.e., within the past 2-3 years) often provide the best quality habitat. Frequently, birds use areas located along gullies, ravine edges, and rocky slopes. Breeding habitat is usually dominated by several species of oaks, including blackjack oak (*Quercus marilandica*), shin oak (*Q. sinuata*), Spanish oak (*Q. texana*), plateau live oak (*Q. mohriana*), and Vasey oak (*Q. pungens* var. *vaseyana*). Suitable habitat also includes other deciduous and non-deciduous species such as Ashe juniper, Texas persimmon (*Diospyros texana*), rough-leaf dogwood (*Cornus drummondii*), redbud (*Cereis canadensis*), and several sumac species (*Rhus* spp.) (Grzybowski 1995). In general, the black-capped vireo will avoid areas dominated by Ashe juniper (Tazik, Grzybowski, and Cornelius 1993). Height of vegetation rarely exceeds 6 ft (1.8 m) and total woody cover ranges between 36 and 55 percent over the breeding range (Grzybowski 1995).

Behavior: The black-capped vireo is a Neotropical migrant that winters in western Mexico. The bird generally arrives on the breeding grounds in Texas in mid-March through mid- to late-April and departs for the wintering grounds in late August through September. Birds breeding in the northern portion of its range may arrive on the breeding grounds up to a month later than birds in the southern portion of the range. Individuals likely follow a circum-Gulf migration route, perhaps using rivers along the Mexican Plateau to guide their journey. Males generally arrive about a week earlier than females. Juveniles often depart for winter areas before adults (usually in late August), followed by adult females (late August – early September), and then adult males (September) (Grzybowski 1995).

Reproduction: Pair bonds are formed upon arrival of the females on the breeding grounds. Females apparently assess male quality while also assessing quality of the territory (Graber 1961, Grzybowski 1995). The black-capped vireo is one of few passerines that show delayed maturation of males. First year males have a much lighter cap than adult males, generally appearing more gray than black. First year males often remain unmated during their first breeding season, but may occasionally breed later during the season with females attempting a second brood. Second year males breed earlier, attain territories in high quality habitat, and often have higher reproductive success than first year males. Most females become reproductively active during their first breeding season. Males court females through a series of displays and specific song types. The courtship period may last only 1 – 2 days before nest construction begins. Males and females usually select potential nest sites together, and both will work together to build the nest. Nest site selection may take between 6 and 9 days for the first nesting attempt. The female generally spends more time building the nest than the male, and is often responsible for the entire nest construction during second nesting attempts, particularly if the male is occupied with caring for the first brood. Males may construct a 'pre-nest' that consists of small gatherings of nest material placed on the fork of a branch. Such small constructions are thought to entice the female to breed (Grzybowski 1995). Nests are often placed in terminal or subterminal forks on branches that range between 0.5 and 10.0 ft (0.2 and 3.0 m) in height. Branches typically lean into open areas within the habitat. Deciduous trees and shrubs, particularly oaks, are the preferred nesting locations. Other tree species used for nesting include sugarberry (*Celtis laevigata*), evergreen sumac (*R. virens*), and Texas persimmon; these birds rarely nest in junipers (Tazik and Cornelius 1993, Grzybowski 1995).

The female lays three to five eggs during the first nesting attempt with four eggs being the most common number laid. Occasionally, clutches may consist of three eggs, but rarely five (Grzybowski 1995). Both male and female incubate the eggs, which generally hatch within 14 to 17 days. The female may incubate alone if the male is occupied with a prior brood. Both males and females feed nestlings, yet males often bring 70 to 80 percent of food items. Young usually fledge at 9 to 12 days old. Frequently, males tend to fledged young more than females. Most young attain independence from parents around 28 days after fledging, yet adults may occasionally feed young 35 – 45 days after fledging. Pairs will readily re-nest after a failed nesting attempt; approximately 25 percent of females are successful in raising two broods when parasitism by the brown-headed cowbird is low. After successfully raising a brood of young, females tend to follow one of several options: (1) help male attend all fledged young, (2) help male by tending to a portion of young on the territory, (3) re-mate with male and initiate new nest while leaving care of brood entirely to the male, (4) re-mate with a different male while leaving care of entire brood with first male, or (5) leave the territory with a portion of the brood, leaving the male to care for the remainder (Grzybowski 1995).

Food Habits: Black-capped vireos are insectivores during the breeding season, gleaning insects off the foliage of oaks and other deciduous trees (Graber 1961, Grzybowski 1995). The common prey items found in stomach contents include spiders and insects of the orders Lepidoptera, Coleoptera, Hemiptera, and Homoptera (Graber 1961). Less common prey include Orthopterans, Neuropterans, Odonatans, Dipterans, and centipedes. The young are fed small insect larvae, and prey items become larger as the young mature. Approximately 30 percent of diet of the young consists of Orthopterans. During winter, black-capped vireos switch to an omnivorous diet, and nearly 50 percent of stomach contents sampled from western Mexico included seeds (Graber 1961). During summer, the vireo can derive water from insect prey and can survive without an open water source; however, the birds will often utilize water moisture, dew, and raindrops when available.

Impacts: Severe population declines for the black-capped vireo probably began during the early 1930s and are due to extensive habitat loss, invasion of the parasitic brown-headed cowbird, and increased predation pressure in highly urbanized and fragmented landscapes (Grzybowski 1995; Weinberg, Hayden, and Cornelius 1998). These impacts on black-capped vireo populations are interrelated, with habitat loss from agriculture and cattle grazing practices opening the way for the inevitable invasion of the cowbird. The black-capped vireo utilizes early-successional habitat that was historically maintained through natural fires. Fire suppression throughout the species range is the primary factor reducing the availability of suitable habitat. Without regular fires, scrubland areas become dominated by large trees that overshadow and limit the understory vegetative layer essential for nesting. Similarly, extensive grazing can denude an area of much of the vegetative growth needed by the birds as nesting and foraging substrates and much of the potential habitat for this species within the Edwards Plateau region is severely overgrazed (Grzybowski 1995). The increasing human population in the region has resulted in continued habitat loss and fragmentation of remaining habitats from urbanization, and can impact vireo populations by exposing isolated breeding populations to increased predation from raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), blue jays (*Cyanocitta cristata*), and domestic cats (*Felis catus*). Also of increasing concern is the spread of fire ants (*Solenopsis wagneri*), which are negatively impacting breeding success on territories in Travis County, TX (Grzybowski 1995).

Black-capped vireos are particularly vulnerable to cowbird parasitism. In central Texas, there is a high demand for rangeland for livestock grazing. Livestock have a twofold impact on the nesting ecology of this vireo: first, overgrazing can severely reduce the suitability of the breeding habitat, and second, livestock attract large numbers of brown-headed cowbirds. On Fort Hood, TX, in 1987, nearly 90 percent of all black-capped nests were parasitized (Tazik and Cornelius 1993; Weinburg, Hayden and Cornelius 1998). Unlike the golden-cheeked warbler, the black-capped vireo is unable to raise both vireo and cowbird chicks. Once a vireo's nest has been parasitized, the nest will likely fail. A parasitized nest will only produce vireo chicks if the cowbird eggs fail to hatch (Grzybowski 1995). Therefore, heavily parasitized populations of this vireo cannot reproduce sufficiently to maintain viable populations. Breeding populations that are unable to maintain viability are likely to disappear, thus increasing the probability of local extirpations throughout the range.

Management: Currently, most management efforts focus on cowbird control. Cowbird removal has successfully maintained and increased populations in the Wichita Mountains, OK; Kerr Wildlife Management Area, TX; and Fort Hood, TX. The cowbird program on Fort Hood destroyed approximately 17,000 individual cowbirds in 1998, which resulted in dramatic increases in reproductive success and population density estimates for the vireo throughout the installation (Wienberg, Hayden, and Cornelius 1998). Fort Hood has also implemented intensive population monitoring that includes annual surveys, monitoring of marked individuals (with leg bands), nest searches and monitoring of nesting success, and continued recording of predation and parasitism rates. These monitoring efforts help to evaluate the success of cowbird control and habitat management on black-capped vireo populations. Eliminating cattle grazing from selected areas around Fort Hood also reduced parasitism rates for breeding black-capped vireos. Cowbird parasitism may be reduced significantly by grazing cattle on pastures far from breeding black-capped vireos. Careful rotation of cattle on various pastures during the year can ensure that suitable grazing pastures away from black-capped vireos are available during the spring and summer months (Campbell 1995).

Efforts to create and maintain suitable breeding habitat have also helped to increase breeding populations of this vireo. Since fire suppression often results in overgrowth of vegetation that degrades black-capped vireo habitat, a program of prescribed burning is essential in maintaining suitable breeding habitat. Of prime importance is the control of Ashe juniper while promoting the small, broad-leaved shrubs used by nesting vireos. This can be accomplished by using cool season burns (before March) every 4 to 7 years (Campbell 1995). Prescribed burning can also be conducted in the fall and spring, to foster high-temperature burns that create or restore early-successional habitat for vireos. Ashe juniper can also be controlled by selective brush management using mechanical methods or by judicious application of herbicides. Mechanical methods include handcutting, chaining, roller chopping, and shredding, and can be used during the non-breeding season to maintain or create suitable habitat. Mechanical methods can also enhance habitat by encouraging re-sprouting of target broad-leaved shrubs. Herbicides are often the most economical means of controlling Ashe juniper and prickly-pear (*Opuntia* spp.); however, herbicides must be applied carefully to avoid damage to desirable tree and shrub species. Early successional habitat can also be maintained through minimal grazing by domestic or wild herbivores. Generally, grazing by cattle and white-tailed deer (*Odocoileus virginianus*) is less destructive of vireo habitat than grazing by goats and other non-native animals. Suitable growth of desired vegetation may be achieved by limiting grazing during the spring and summer. Through establishment of grazing rotation systems

and control of deer populations, managed grazing practices can be used to maintain habitat for breeding black-capped vireos (Campbell 1995).

The black-capped vireo is likely an area-sensitive species (Askins 1993). Although several thousand acres of suitable habitat exist on Fort Hood, current estimates of reproductive success suggest that the population is not yet self-sustaining (Tazik and Cornelius 1993; Wienberg, Hayden, and Cornelius 1998). Therefore, current and future management of black-capped vireo populations should continue to maintain and restore suitable breeding habitat. Efforts should be made to increase the size of current breeding patches of habitat, link isolated patches, and reduce overall fragmentation of habitat regionally. Historically, large tracts of suitable breeding habitat may have buffered black-capped vireo populations from the effects of cowbird parasitism (Rothstein 1994). However, the current level of habitat degradation existing throughout the range of this species has magnified the impacts of parasitism to such a degree that the vireo will be unable to persist without continued intensive cowbird control (Wienberg, Hayden, and Cornelius 1998). A program of cowbird trapping and shooting should remain an essential component of any management strategy for the black-capped vireo. Additionally, vireo populations should continue to be monitored to determine the effectiveness of current and future management actions and to guide future management decisions for ensuring the long-term persistence of the species.

GOLDEN-CHEEKED WARBLER (*Dendroica chrysoparia*)

Distribution: The golden-cheeked warbler is the only breeding bird endemic entirely to the state of Texas. Centered mainly within the Edwards Plateau region of south-central Texas, this warbler is limited to approximately 25 counties (Ladd and Gass 1999; U.S. Geological Survey, Northern Prairie Wildlife Research Center (USGS-NPWRC) 2001) (Figure 3). Within these counties, the breeding range is localized and patchily distributed. The golden-cheeked warbler winters in the highlands of southern Mexico and south through Guatemala, Honduras, and Nicaragua (Ladd and Gass 1999). It is also noted incidentally on the Farallon Islands of California, on the Virgin Islands, and eastern Florida (DeGraaf and Rappole 1995, Ladd and Gass 1999).

Status: Rare, yet locally common in south-central Texas, the golden-cheeked warbler was first proposed for listing as endangered under the ESA on May 4, 1990 (USFWS 1990a, 1990b), and officially listed as endangered on December 27, 1990 (USFWS 1990c). Based on available habitat, the total population for this warbler on the breeding range was estimated between 4,822 and 16,016 pairs (Ladd and Gass 1999). One of the largest, localized populations of breeding golden-cheeked warblers exists on Fort Hood, TX, where an estimated 2,000 to 2,500 pairs have been documented (U.S. Army, Fort Hood, DPW 2001). Few long-term trend data exist for populations of this warbler; however, based on the amount of declining habitat, the population was estimated to have declined 25 percent between 1962 and 1981 (USFWS 1992, Ladd and Gass 1999). Ten years of survey data on the Camp Bullis Training Site of Fort Sam Houston, in central Texas, show a stable to slightly increasing population between 1991 and 2000 (Fischer and Guilfoyle 2001).

Figure 3. Breeding and wintering range of the golden-cheeked warbler in North America and Mexico (adapted from Ladd and Gass (1999) and the National Geogrphic Society (1999))

Habitat: Golden-cheeked warblers are restricted to mature Ashe juniper stands mixed with other deciduous tree species, particularly oaks. These stands are often narrow strips of woodlands found within the Texas Hill Country and are locally referred to as "cedar brakes" (Texas Parks and Wildlife (TPW) 2001). Mature Ashe juniper stands suitable for this warbler are often over 250 acres (100 ha) and have a mixture of oaks, including Spanish oak and plateau live oak, in the central portion of the range. Northern and southwestern portions of the range may have a mixture that includes shin oak and Lacey oak (*Q. glaucoides*) (Campbell 1995, Ladd and Gass 1999). Other deciduous and evergreen tree and shrub species that are a component of these woodlands include sugarberry, cedar elm (*Ulmus crassifolia*), walnut (*Juglans* spp.), Texas ash (*Fraxinus texensis*), black cherry (*Prunus serotina*), sycamore (*Platanus occidentalis*), American elm (*U. americana*), coma (*Bumelia lanuginosa*), redbud, rough-leaf dogwood, Texas persimmon, elbow bush (*Foresteria pubescens*), Texas mountain laurel (*Sophora secundiflora*), possum-haw (*Ilex decidua*), evergreen sumac, and polecat bush (*R. aromatica*). Forest stands typically average about 40 years in age and 20 ft (6.0 m) in height, with about 70-percent canopy cover and a tree density of 400 trees/acre (about 1,000 trees per ha) (Ladd and Gass 1999). Nesting areas within Ashe juniper stands are often located in steep canyons, yet birds will generally nest wherever suitable habitat exists. Numerous measures of reproductive performance including territory density, age distribution, pairing success, overall reproductive success, or brood size did not differ between populations nesting in flat uplands versus canyon areas (Ladd and Gass 1999). The bark from the Ashe juniper tree is an integral component of the golden-cheek warbler's nest. The loose, stringy

nature of the Ashe juniper bark is only observed in older, mature trees; hence the reliance of the golden-cheeked warbler on mature Ashe juniper stands.

Behavior: The golden-cheeked warbler is a Neotropical migrant bird that winters in high elevation pine (*Pinus* spp.) and pine-oak forests of southern Mexico and Central America. There is no evidence of a trans-Gulf migration; rather, this species likely migrates along a circum-Gulf route through the Sierra Madre Oriental of eastern Mexico. Individuals generally arrive on the breeding grounds in mid-March and depart in mid-July during fall migration. Some individuals may depart as early as mid-June and as late as early August (Ladd and Gass 1999). Difference in timing of migration between males and females and between adults and juveniles has not been investigated. During migration, these birds have been reported to flock with black-throated green warblers (*Dendroica virens*) and other passerines (Johnson et al. 1988, Ladd and Gass 1999).

Reproduction: Males and females form pairs shortly upon arrival at the breeding grounds. Both sexes exhibit display postures during courtship. The females will collect material for the nest with the male singing nearby. Often, the male will collect nest material and present it for inclusion in the nest; after presenting the female with a bark strip, copulation may follow (Campbell 1995, Lockwood 1996). Nesting material usually includes strips of juniper bark. The female appears solely responsible for nest construction, although the male may play an important role in acquiring material. Nest construction takes about 4 to 6 days (Lockwood 1996). Nests are usually placed in a vertical fork of a branch and located about 15 ft (4.6 m) above the ground (Campbell 1995). Sexes are generally monogamous during the breeding season, but on occasion males have been observed with more than one female and feeding multiple broods. One female was observed mating with three different males in a single season (Ladd and Gass 1999). Females typically lay three or four eggs, but on rare occasions may lay as many as five. Egg laying occurs about 3 to 4 days after nest construction and about one egg is laid per day. Only the female develops an incubation patch and, therefore, performs all incubation duties. The male has been observed to feed the female during the incubation period. Both the female and male feed the young before and after fledging. Young will depart the nest approximately 9 to 12 days after hatching and will become independent from adults in approximately 28 days. Adults will occasionally produce two broods per year, but more often produce only one (Ladd and Gass 1999).

Food Habits: Golden-cheeked warblers are known to be entirely insectivorous during the breeding season. Diet during migration and wintering seasons are unknown. Birds typically forage in the foliage of Ashe juniper and numerous oak species and prey largely upon Lepidopteran larvae, Hemipterans, Homopterans, Coleopterans, spiders and other arthropods. Evergreen juniper trees are utilized more for foraging than are deciduous trees. Small insects are swallowed whole, while larger insects are crushed against branches, folded, and swallowed (Ladd and Gass 1999). These birds may focus foraging activities on insect outbreaks occurring on different plant species during the breeding season. Birds may forage largely on oak foliage during March and early April, and then switch to Ash juniper during late April and June (Campbell 1995, Ladd and Gass 1999).

Impacts: Habitat loss and fragmentation of existing habitat are directly related to declines of golden-cheeked warbler populations. Indirect causes of population decline include high rates of parasitism by the brown-headed cowbird and high predation rates in fragmented areas. The large increase in the human population in central Texas has created strong demand for the conversion of

natural habitats to agriculture, grazing rangeland, and urban areas (Campbell 1995, Ladd and Gass 1999). Habitat has also been lost when areas were flooded to create artificial lakes (TPW 2001). Mature Ashe juniper stands require many decades to develop; therefore, once the habitat is lost, the recovery rate is exceedingly slow. Small, isolated stands are usually subjected to high rates of parasitism that either reduce or eliminate reproductive success for the species. Unlike the black-capped vireo, the golden-cheeked warbler is capable of producing young from a parasitized nest. However, parasitism rates in fragmented habitats can be so pervasive that local populations of golden-cheeked warblers can be devastated (Ladd and Gass 1999).

Management: The first step in managing golden-cheeked warbler populations is to identify known breeding areas. Areas of canyon slopes and creek bottoms with mature forests of mixed Ashe juniper and hardwoods should be identified and protected as areas with the highest probability of supporting breeding golden-cheeked warblers. Mature forested areas with 50 percent or greater canopy cover in flat or rolling uplands are also likely to attract breeding warblers. Additionally, patchy woodlands containing mature oaks and junipers may be used by golden-cheeked warblers. Although patchy woodlands may not attract breeding individuals, or may not represent ideal breeding habitat, these areas may support fledglings after the peak breeding period (Campbell 1995). Patchy or flat woodlands surrounding ideal breeding habitat can function as a buffer and may serve to protect golden-cheeked warbler populations from other land-use practices, including cattle grazing, urban growth, and agricultural practices. A woodland buffer of approximately 300 ft (91.5 m) around patches of high quality breeding habitat is suggested (Campbell 1995). Once breeding areas are identified, it is recommended that these areas be protected and disturbance minimized. Minimal disturbance appropriate for golden-cheeked warblers will depend on the area of forest tract being protected. In general, it is advised that fencelines, roads, and livestock watering areas be placed outside of identified warbler habitat. In large tracts, linear openings of 16 ft (5 m) or less should not significantly degrade the habitat. Also, removal of juniper trees 10 ft (3 m) or less for use as fence posts should have a minimal impact on habitat quality for the golden-cheeked warbler (Campbell 1995). However, all planned disturbances should occur during the non-breeding season.

Habitat loss and degradation are the primary factors negatively impacting golden-cheeked warbler populations; therefore, habitat restoration is strongly recommended. Golden-cheeked warblers are reported to colonize and use restored areas, justifying habitat restoration as a primary tool in the management of this species. As with the black-capped vireo, planned restoration efforts should focus on increasing the size of small forest tracts, linking other isolated tracts, and reducing overall fragmentation of the landscape. Although golden-cheeked warblers have been reported to breed in tracts as small as 12 acres (5 ha), much larger tracts are likely needed to maintain populations (Campbell 1995). Efforts should focus on restoring forest tracts of 50 acres (20 ha) and larger. Restoration efforts should occur on areas where Ashe juniper is currently found or was found formerly. Lowland, mesic sites, especially areas with steep slopes, are the best sites to restore for golden-cheeked warblers. Early successional areas where young junipers are dominant should be thinned to promote hardwood regeneration. Prescribed burning may also be used to control dense stands of juniper. Intensive grazing may prevent the establishment of hardwood seedlings; therefore, grazing should be deterred and deer herds should be controlled when possible.

SUMMARY: Several non-riparian songbird species may be impacted by USACE reservoir operations. Fire suppression, urban expansion, cattle grazing, and reservoir construction are factors negatively impacting populations of two endangered species, the black-capped vireo and golden-cheeked warbler. These species are found on several Corps projects and military installations in central Texas. This note summarizes the biology, life history, and habitat requirements of these birds and provides general guidelines for managing their populations and avoiding land-use conflicts. Corps project personnel should be aware of the potential to improve habitat conditions for these species through protection of breeding areas, habitat restoration, cowbird control, and proper cattle management.

POINTS OF CONTACT: For additional information, contact Mr. Michael P. Guilfoyle (601-634-3432, *Michael.P.Guilfoyle@erdc.usace.army.mil*), Mr. Chester O. Martin (601-634-3958, *Chester.O.Martin@erdc.usace.army.mil*), or the program manager of the Ecosystem Management and Restoration Research Program, Mr. Glenn Rhett (601-634-3717, *Glenn.G.Rhett@erdc.usace.army.mil*). This technical note should be cited as follows:

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Black-capped Vireo and Golden-cheeked Warbler. Photos and all copyrights belong to Texas, Parks and Wildlife. Permission for use of photos granted by Ms. Kathleen B. Martin, Web Content Manager, Texas, Parks and Wildlife, Austin, TX. 30 November 2001. *http://www.tpwd.state.tx.us*

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